Name of Model

#15

Calculations are wrong

DUST EXPOSURE CALCULATION WORKSHEET				
DustLevel		Safety Factor for this site = 2		
Chemical	Exposure Limit (mg/m3)	Maximum Soil Concentration (mg/kg)	Exposure Limit Based on Single Compound (EL Mix, mg/m3)	Dust Quotient for Each Compound (level/limit)
Aluminum	5	1.E-9	2.5E+15	2.00E-10
Antimony	0.5	1.E-9	2.5E+14	2.00E-09
Arsenic 56	0.01	1.E-9	5.E+12	1.00E-07
Barium ~~5.T~~	0.5	1.E-9	2.5E+14	2.00E-09
Beryllium 5.1	0.002	1.E-9	1.E+12	5.00E-07
Cadmium 143	0.005	1.E-9	2.5E+12	2.00E-07
Chlordane	0.5	1.E-9	2.5E+14	2.00E-09
Chromium	0.5	1.E-9	2.5E+14	2.00E-09
Chrome (hex)	0.01	1.E-9	5.E+12	1.00E-07
Cobalt	0.02	1.E-9	1.E+13	5.00E-08
Copper 1,970	1	1.E-9	5.E+14	1.00E-09
Cyanides	5	1.E-9	2.5E+15	2.00E-10
1.7 ? V 911 ppb Dioxins (hex) 1.71 ppb	0.001	0.001	5.E+5	1.00E+00
Endosulfan	0.1	1.E-9	5.E+13	1.00E-08
Fluorides	2.5	1.E-9	1.25E+15	4.00E-10
Lead 172,000	0.05	10,200	2.45	2.04E+05
Manganese	0.2	1.E-9	1.E+14	5.00E-09
Mercury	0.025	1.E-9	1.25E+13	4.00E-08
Nickel	1	1.E-9	5.E+14	1.00E-09
172,000 Oil Mist	5	1.E-9	2.5E+15	2.00E-10
PCBs 570	0.5	1.E-9	2.5E+14	2.00E-09
PNAs	0.2	1.E-9	1.E+14	5.00E-09
Phthalates 1,500	5	1.E-9	2.5E+15	2.00E-10
RDX	0.5	1.E-9	2.5E+14	2.00E-09
Selenium	0.2	1.E-9	1.E+14	5.00E-09
Silica	0.05	1.E-9	2.5E+13	2.00E-08
Silver	0.01	1.E-9	5.E+12	1.00E-07
Thallium	0.1	1.E-9	5.E+13	1.00E-08
Tin	2	1.E-9	1.E+15	5.00E-10
Titanium	10	1.E-9	5.E+15	1.00E-10
Trinitrotoluene	0.1	1.E-9	5.E+13	1.00E-08
Vanadium	0.05	1.E-9	2.5E+13	2.00E-08
Zinc	5	1.E-9	2.5E+15	2.00E-10
			Sum	2.04E+05
Dust Exposure Level at Mixture PEL =			2.451	

check with Mike on this model is it approved AIGCH accepted

343080

Lead @ 10,200

$$\frac{10^6 \text{ mg/kg} \times .05 \text{ mg/m}^3}{10{,}200 \text{ mg/kg} \times (4)}$$

$$\frac{50{,}000}{40{,}800} = 1.225 \text{ mg/m}^3$$

Particulate exposure % of contaminant calculation

soils. As a precautionary measure, PID monitoring will be conducted with action levels based on benzene (PEL 1 ppm). This should protect against any organic vapors that may be generated.

The primary hazard for personnel exposure is contact, ingestion, and inhalation of contaminated soils. These contaminants are chemicals with extremely low volatility (i.e., PNAs, PCBs, dioxins, pesticides, and herbicides) that are bound to soil particles and metals (primarily arsenic). The particulate hazard presenting the greatest exposure potential is arsenic. As can be seen in the following calculations, a total dust action level of $1 mg/m^3$ will be required to protect against exposure.

Below is a rough calculation generally used to determine the concentration of airborne particulate matter that would be necessary to exceed the PEL for arsenic. The primary logic used in developing the equation was to determine the maximum percentage of arsenic in soil. The first assumption is that for any concentration of suspended particulates, the maximum percentage of arsenic would be in the dispersion. The next step is to utilize the PEL to establish the airborne particulate concentration at which the PEL would be reached.

This is done as follows:

8010 ppm = the maximum soil concentration of arsenic

8010 ppm/1,000,000 = .00801 (percent contamination in one million parts)

The established PEL for arsenic is $0.010 mg/m^3$. In order to determine the levels of total dust required to reach this PEL, the first step is to multiply the maximum airborne concentration of total particulates by the percent present in soil to provide the concentration of arsenic suspended in the total particulates. The following equation may be used to establish the total particulate concentration in air required to exceed the PEL for arsenic.

X = total dust concentration in air

P = % contaminant in soil

C = given PEL for compound

so,

$X \times P = C$

To determine the airborne concentration at which the PEL will be reached, we must solve for X. The solution follows:

X = unknown

P = 0.008010 %

C = 0.010 mg/m^3

$$X = C/P$$
$$= 0.010/0.008010\%$$
$$= 1.24\ mg/m^3$$

Based on the above calculations, 1.24 mg/m^3 of total dust would contain enough arsenic to exceed the PEL of 0.010 mg/m^3. These levels of total dust are likely to be generated during soil disturbance activities due to the low value. In order to prevent the action level from being exceeded, dust control measures will be instituted when the action level is observed.

The low total dust action level required to protect against arsenic exposure will also be adequate to control other particulate hazards. After arsenic, pesticides are the next most serious concern for worker exposure. Pesticides are heavy, nonvolatile compounds that are attached to soil particles and are, therefore, a particulate hazard. The alpha and gamma isomers of benzene hexachloride (BHC) are the most likely to be present in airborne dust in quantities large enough to exceed the PEL because of their high soil concentrations. The PEL for the gamma isomer of BHC is 0.5 mg/m^3. No PEL for the alpha isomer has been established, but it is reasonable to assume that since the gamma isomer has been determined to be the most toxic of the BHC isomers[2], the PEL for gamma BHC may be used in estimating exposure limits for alpha BHC as a conservative estimate.

Using the same method for calculating total dust action levels for arsenic, concentrations of total dust required to exceed the PEL for the BHC isomers may be established. The calculations, with the same variables (X, P, and C), for determining the action levels for the alpha and gamma isomers of BHC are as follows:

2. Sittig, Marshall <u>Handbook of Toxic and Hazardous Chemicals and Carcinogens</u>, 2nd Ed., Noyes Publications, 1985, page 487.

Alpha BHC

X = unknown

P = 45,000 ppm - 0.045% (concentration of alpha BHC in soil)

$C = 0.5\ mg/m^3$ (PEL of gamma BHC)

$X = C/P$

$= 0.5\ mg/m^3/0.045\%$

$= 11.11\ mg/m^3$ (total dust required to exceed the estimated PEL for alpha BHC)

Gamma BHC

X = unknown

P = 23,000 ppm - 0.023 (concentration of gamma BHC in soil)

$C = 0.5\ mg/m^3$ (PEL of gamma BHC)

$X = C/P$

$= 0.5\ mg/m^3/0.023\%$

$= 21.7\ mg/m^3$ (total dust required to exceed the PEL for gamma BHC)

The action level for arsenic, as demonstrated by the above calculations should be adequate to protect personnel against exposure to BHC. Note also that vision would be compromised at such values, and dust control measures would be instituted at values below 11.11 and 21.7 mg/m^3.

Although dioxins are present, measures to control arsenic exposure should protect against dioxins as an airborne particulate since they are present only in trace amounts (parts per billion range) in the soil and have a very low volatility. Silvex, an herbicide, may possibly contain dioxins and is in higher soil concentrations (3.1 parts per million). However, it is also a particulate hazard and its concentration is low enough that methods to control arsenic exposure should be adequate against Silvex as an airborne contaminant. Although no PEL is established, evidence available, as stated earlier, indicates that long-term serious health risks are questionable. The primary risk of exposure to dioxin is contact with or ingestion of contaminated soil.

PNAs such as pyrene are also present in soil. These compounds are basically a particulate hazard since they are large and heavy and typically do not volatilize in air. These contaminants are not in high enough levels in soil (maximum concentrations below 18 ppm) to present a hazard in total airborne dust. Using the calculation method for determining total dust action level, 11,111 mg/m^3 of total dust would have to be present to exceed the PEL for pyrene (0.2 mg/m^3). Vision would be severely impaired long before such levels of total dust would be reached. Other PNAs (with equal or greater PELs) are in soil concentrations equivalent to pyrene. Therefore, the primary hazard from PNAs is due to contact or ingestion of contaminated soils.

4.3.3 Risk Analysis for Off-Site Personnel/Communities

Because contaminants on site are primarily a particulate hazards, the primary concern for preventing exposure to off-site personnel and any surrounding communities will be the control of fugitive dusts migrating off-site.

Air monitoring will be conducted to determine whether dust levels produced exceed established background levels (see Section 10). Should dust exceed established action levels, work will not be permitted to continue until steps are taken to reduce dusts generated by site activities to background levels.

4.3.4 Control Methods

In all situations, control methods to be employed to minimize exposure are as follows:

- Engineering
  - Dust levels will be controlled to prevent migration of dust above established background levels off site in accordance with contract specifications.
- Administrative
  - Distance between worker and actual contaminated area, i.e., placing heavy equipment on clean side during certain activities to provide some measure of remoteness to the operation.
  - Staying upwind from contaminant emissions.
- PPE
  - Use of respiratory and personnel protection as required to prevent inhalation of or contact with contaminated soils.

CALCULATING PARTICULATE ACTION LEVELS

7.1 No Contaminant of Concern

For job-sites where there is no contaminant of concern, keep exposure to respirable nuisance dusts, below the OSHA PEL of 5 mg/m^3. This implies that work teams will don respirators when the concentration of respirable dust exceeds 2.5 mg/m^3. See Section 8.1.

7.2 One Contaminant of Concern

For job-sites with a single contaminant of concern (such as cadmium), the following formula can be used to establish an exposure limit.

$$EL_{mix} = \frac{(EL\ mg/m^3)}{(conc\ g/g)\ (Safety\ Factor)} = \frac{(10^6\ mg/Kg)\ (EL\ mg/m^3)}{(conc\ mg/Kg)\ (Safety\ Factor)}$$

Where:

EL_{mix}:	Air concentration of total dust at which the contaminants of concern would be at their established exposure limit.
EL:	Exposure limit of the contaminant of concern, e.g., its PEL, REL, or TLV, whichever is lower, in mg/m^3
10^6:	Conversion factor
conc:	Soil concentration of the contaminant of concern in mg/kg
Safety Factor:	A number between one and ten used to account for the degree of confidence.

The safety factor is dependent on whether:

- The concentration of the contaminant in the airborne dust is the same as its concentration in soil.
- The soil concentration data depicts a representative or worst case.
- The monitoring instrument used accurately reports the concentration of dust in air (a respirable dust monitor will under-report the concentration of total dust in air).

If your confidence that the data represent site conditions well, use a safety factor of 2. If you have no confidence, use 10. In the absence of other information, use 4.

Example:

Cadmium in soil at 2,000 ppm. TLV = 0.05 mg/m^3

$$\text{Exposure Limit, } EL_{mix} = \frac{(10^6 mg/Kg)\ (.05\ mg/m^3)}{(2000\ mg/Kg)\ (4)} = 6.25\ mg/m^3$$

In the example, cadmium at 2,000 mg/Kg (ppm) results in a dust exposure limit of 6.25 mg/m³. When the atmosphere contains 6.25 mg/m³ of total dust, it contains no more than 0.05 mg/m³ of cadmium, its TLV. Respiratory protection would be recommended at respirable dust levels of 2.5 mg/m³, one half of the OSHA dust PEL. Cadmium would not present a health problem in this case.

7.3 Several Contaminants with a Collective Exposure Limit

For sites contaminated with chemicals that have a collective limit [e.g., polynuclear aromatic hydrocarbons (PNAs)], the sum of the total contaminants found in soils should be used to establish soil concentration. The equation below can be used to establish the exposure limit:

$$EL_{mix} = \frac{(EL(c)\ mg/m^3)}{(\Sigma conc\ mg/Kg)\ (Safety\ Factor)} = \frac{(10^6\ mg/Kg)\ (EL(c)\ mg/m^3)}{(\Sigma conc\ mg/Kg)\ (Safety\ Factor)}$$

Where:

EL(c): Collective exposure limit, e.g., the TLV or PEL, whichever is lower, for the group as a whole, in mg/m³.

Σconc: Sum of the soil concentrations of the contaminants of concern in mg/Kg

All other terms are defined as in Section 7.2.

Example:

Total polycyclic aromatic hydrocarbon concentration in soil is 4,500 mg/Kg, EL(c) = 0.2 mg/m³.

$$EL_{mix} = \frac{(10^6\ mg/Kg)\ (0.2\ mg/m^3)}{(4{,}500\ mg/Kg)\ (4)} = 11\ mg/m^3$$

Again, the nuisance dust TLV would apply before the exposure limit for PNAs was reached. Respiratory protection would be recommended at one half the dust limit or 2.5 mg/m³. A full face respirator with a high efficiency and organic vapor filter would be appropriate for this exposure.

7.4 Several Contaminants with Individual Exposure Limits

The previous equation can be used for aerosols of dust containing more than one contaminant of concern by adding individual soil concentration/ TLV (conc/TLV) terms before dividing them into the 10^6 mg/Kg term.

$$EL_{mix} = \frac{(10^6\ mg/Kg)}{[\Sigma(conc_n/EL_n)]\ (Safety\ Factor)}$$

Where:

EL_n = Established exposure limit for each contaminant of concern in the soil.

The remaining terms are defined as in Sections 7.2 and 7.3.

The easiest way to apply the formula above is through use of a table like the example shown below.

Contaminant	OSHA PEL	ACGIH TLV	Soil Conc	$Conc_n/BL_n$
Arsenic	0.01*	0.20	1,500	150,000
Cadmium	0.20	0.05*	2,000	40,000
Chromium	0.50	0.05*	1,000	20,000
Nickel	1.00	1.00*	500	500
Lead	0.05*	0.15	2,500	50,000
Total				260,500

* This limit was used as BL_n

$$BL_{mix} = \frac{(10^6 \text{ mg/Kg})}{(260,500)\ (4)} = 0.96 \text{ mg/m}^3$$

An exposure limit of 1.0 mg/m³ would be established for this soil. Respiratory protection would be recommended for any activity producing dust, for windy conditions, or when dust is visible (Section 8.1).